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A taxonomic review of *Sturmiopsis* Townsend, 1916, an Old World genus of Tachinidae (Diptera) parasitising economically significant lepidopterous stem borers

by

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ABSTRACT

Sturmiopsis Townsend is an important larval parasitoid of lepidopterous stem borers in the Afrotropical and Oriental Regions, and there is a substantial literature relating to the potential role of its included species as biological control agents of economically significant pest species. Two species have been described from Africa, namely *Sturmiopsis angustifrons* Mesnil, 1959, and *S. parasitica* (Curran, 1939), the latter distributed from Southern into East Africa, but also represented in West Africa. There has been uncertainty about whether *S. angustifrons* and *S. parasitica* are distinct species, and given the use of *Sturmiopsis parasitica* as a putative biocontrol agent of *Eldana saccharina* Walker, a pyralid stem borer which has had a considerable impact on the sugarcane industry, a taxonomic review of the genus was indicated. This paper provides a taxonomic review of *Sturmiopsis*, a generic diagnosis, and a detailed key to the three valid species. A careful study of *Sturmiopsis* specimens from localities throughout Africa revealed that it was impossible to distinguish *S. angustifrons* from *S. parasitica*, and consequently *angustifrons* is newly synonymised with *parasitica*. The two other valid *Sturmiopsis* species are *S. inferens* Townsend, 1916, which is widespread in the Oriental Region, and *S. emdeni* Mesnil, 1952, a little-known species currently known only from Israel. *Sturmiopsis parasitica* is redescribed; there appear to be two allopatric African populations, one from Southern and East Africa, and the other from West Africa. These populations are distinguished by subtle differences in the shape of the male surstylus in profile. The first known male of *S. emdeni* is recorded and described.

INTRODUCTION

The Tachinidae is almost certainly the largest family of Diptera, which in the Afrotropical Region currently includes just less than 1000 named species. This is probably a fraction of the expected total number of afrotropical species, given the taxonomic difficulties associated with working on Tachinidae and the dearth of alpha-taxonomic activity since 1960. Nearly all Tachinidae are known to be endoparasitoids of other insects, particularly the Lepidoptera and the Coleoptera, and many tachinid hosts are economically important crop pests in commercial agriculture. It is for this reason that there has been significant interest in using Tachinidae as biological control agents, most notably in the last 50 years. In Africa, lepidopterous stem borers have had a notable impact on agriculture, and several tachinid species have been introduced as potential biological control agents. These have included *Paratheresia claripalpis* (van der Wulp) (see e.g. Conlong 1994; Kfir 2001), *Sturmiopsis inferens* Townsend (Ingram 1983; Scheibelreiter 1980) and *Palpozenillia diatraeae* Townsend (Carnegie 1991).

In Africa there has been great concern about the economic impact of the sugarcane stem borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae) on the sugarcane industry. Since 1981 the South African Sugarcane Research Institute (SASRI) at Mount Edgecombe, KwaZulu-Natal, has been involved with the implementation of a biological control programme targeting this important borer. A number of tachinid species have been identified as parasitoids of the borer since then (Conlong 1994, 2000), including a new species of *Schembria* Rondani described by Barraclough (1991). *Sturmiopsis parastica* Curran, 1939 is one of the species which has been extensively studied, and has been identified as an important larval parasitoid of numerous graminaceous African stem borers (Harris 1998). According to Chinwada *et al.* (2004), *S. parasitica* parasitises *Busseola fusca* Fuller (Noctuidae) in the Harare area (Zimbabwe), and in East and West Africa has been recorded from *B. fusca*, *Sesamia calamistis* Hampson, *S. nonagrioides botanephaga* Tams & Bowden (Noctuidae), *Chilo orichalcociliellus* (Strand), *Chilo partellus* (Swinhoe), *Coniesta ignefusalis* (Hampson) (Crambidae) and of course *E. saccharina*. A second species of *Sturmiopsis*, namely *S. inferens* Townsend, 1916, which is widespread in the Oriental Region, has also attracted the attention of economic entomologists, and has even been introduced into Africa in an attempt to target lepidopterous stem borers (Harris 1998). Its occurrence in Madagascar probably relates to a similar introduction to Mauritius against *Chilo sacchariphagus* Bojer (Crambidae) (Greathead 1971). Crosskey (1976) recorded *S. inferens* as a parasitoid of seven species of Pyralidae and *Sesamia inferens* (Noctuidae), from which it derives its name. *Sturmiopsis emdeni* Mesnil, 1952 is a little-known species, recorded only from Israel at present, and is the only species of *Sturmiopsis* lacking life history data.

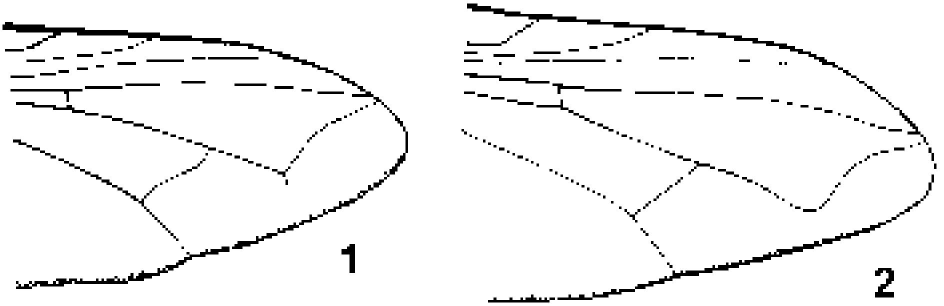
Much time could be spent reviewing the considerable recent literature on *Sturmiopsis* and *S. parasitica* in particular, but virtually all of this relates to the potential use of *S. parasitica* as a biological control agent, or represents some form of life history data (see e.g. Martin *et al.* 2001; Chinwada *et al.* 2004). In contrast, the main purpose of this paper was to taxonomically review the genus *Sturmiopsis*, evaluate the species concepts, provide a detailed and reliable species key, and present accurate descriptions and redescriptions where necessary, but with particular reference to the African fauna. Detailed taxonomic studies of extralimital species were beyond the brief of this study, which was initiated three years ago when I was approached by Dr D. Conlong (SASRI), to resolve confusion relating to the identification of the two named African species. These species were supposedly separated by colour characters and the presence or absence of eye hairing. Obviously the proper identification of taxa used in mass rearing and releases is crucial, and the importance of meaningful taxonomic studies on biological control agents cannot be emphasised enough.

It should be noted that most laboratory-reared specimens seen by me have been omitted from the redescription of *S. parasitica*.

MATERIALS AND METHODS

This study was based on pinned adult flies and associated puparia deposited in the following institutions (acronyms in parentheses)

American Museum of Natural History, New York, USA (AMNH)
British Museum of Natural History, London, UK (BMNH)
Natal Museum, Pietermaritzburg, South Africa (NMSA)
South African Sugar Research Institute, Mount Edgecombe, South Africa (SASRI)
Staatliches Museum für Naturkunde in Stuttgart, Germany (SMNS)
Tel Aviv University Museum, Israel (TAUI)
United States National Museum of Natural History, Washington, D.C., USA (USNM)



Figs 1–2. Wing venation (apical two-thirds), showing positions of bend of M and m-cu. 1. *Sturmiopsis emdeni*. 2. *Sturmiopsis parasitica*. [Not to scale].

Adult flies and associated postabdominal dissections were examined using a Wild M3B stereo microscope with appropriate objectives. All line drawings were made with a drawing tube attached to the same instrument. Scanning electron micrographs were taken in the University of KwaZulu-Natal (Howard College) Electron Microscope Unit, using a LEO 1450 SEM.

The abdominal apex was detached and macerated in hot KOH. Thereafter postabdominal structures were dissected free and the preparations rinsed in alcohol. Dissected terminalia and associated abdominal parts were then stored in glycerine in a microvial pinned beneath each source specimen.

The terminology used mainly concurs with all my recent publications on Tachinidae (see e.g. Crosskey 1984; Barraclough 1992). Reference should be made to the annotated figures in Crosskey (1984). Antennal segment is abbreviated as 'A.s.' The figures of the wing apices are diagrammatic and are not drawn to scale.

Bilaterally symmetrical structures are always described in the singular. Measurements of holotypes are given in parentheses after the range for other specimens examined. Holotype label data are always quoted exactly as they appear; a slash denotes the end of each line. Significant qualifying or supplementary information is presented in square parentheses when considered necessary.

Body length was measured (in profile) from the anterior margin of the third antennal segment to the abdominal base; wing length was measured from the humeral cross-vein to the wing-tip.

KEY TO THE SPECIES OF *STURMIOPSIS*

Note: Distributions exclude introductions to other faunal regions.

1. Abdominal T3 with paired median marginal setae. [Southern, East and West Africa] .... **parasitica** (Curran, 1939)

– Abdominal T3 without median marginal setae. [Israel; widespread in Oriental Region] 2

2. Eye in male completely bare. Second antennal segment just less than half length of third segment. Wing with bend of vein M relatively distant from wing margin, distance two-fifths to half that from vein m-cu (Fig. 1). [Israel] .... **emdeni** Mesnil, 1952

– Eye in male nearly always haired, hairs often relatively profuse and elongate. Second antennal segment length ranges from just more than half to subequal to length of third segment. Wing with bend of vein M close to wing margin, this distance one-fifth to one-third that to vein m-cu (as in Fig. 2). [Widespread in Oriental Region] .... **inferens** Townsend, 1916

TAXONOMY

Genus *Sturmiopsis* Townsend, 1916

Sturmiopsis Townsend, 1916: 313. Type species: *Sturmiopsis inferens* Townsend, 1916, by original designation.

Rhodesina Curran, 1939: 3. Type species: *Rhodesina parasitica* Curran, 1939, by original designation. [Junior homonym, preocc. *Rhodesina* Malloch, 1921.]

Curranomyia Townsend, 1941: 115 (replacement name for *Rhodesina* Curran).

Diagnosis (relative to afrotropical and oriental Sturmiini) (Fig. 3): Male with 2 pairs reclinate orbital setae. Second antennal segment moderate to elongate in length, 0.5–1.0 X length of third segment. Facial ridge with setulae or strong setae on about lower half of height. Parafacial with hairing on almost entire height. Thorax with 4 *post dc*; 2 *stpl*. Humeral callus with 3 or more setae. Scutellum with 2 pairs lateral setae (usually) and apical setae typically directed upwards. Mid tibia with 2 *ad*. Basal node of R_{4+5} usually with 2 or more small setulae. Abdominal T1+2 excavate to hind margin. Intermediate abdominal tergites without discal setae.

Discussion: At present it appears that *Sturmiopsis* comprises three valid species. However, I have seen very little material of *S. emdeni,* and I am concerned that once

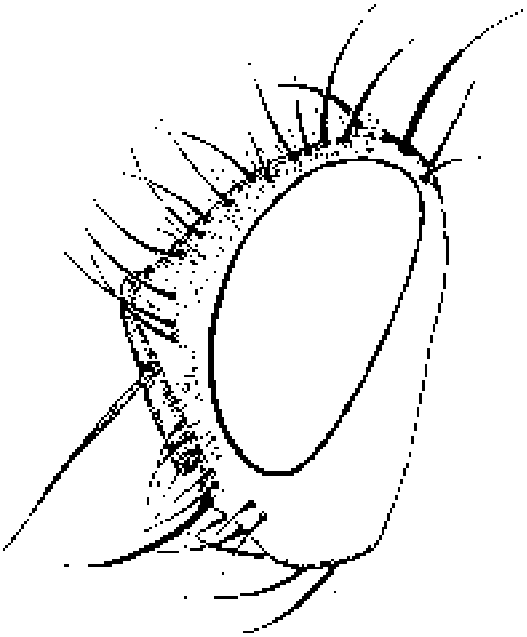


Fig. 3. *Sturmiopsis parasitica*; male holotype, head in profile (vestiture on antenna, eye, occiput and gena omitted).

additional material is examined, it will be difficult to separate *S. emdeni* from *S. inferens*, meaning that *S. emdeni* may prove to be a junior synonym. It would therefore be instructive to examine *Sturmiopsis* material collected from areas between the eastern Mediterranean and India. Despite the dissection and examination of the male postabdomen of a wide range of *Sturmiopsis* material, I have been unable to identify character states which reliably separate all three species. There is marked intra-generic variation in the length of the second antennal segment.

Sturmiopsis emdeni Mesnil, 1952

Figs 1, 6

Sturmiopsis emdeni Mesnil, 1952: 228; Herting 1984: 50.

Type material examined: **Holotype** ♀ (BMNH): ISRAEL: 'Holo- / type' [circular label with red perimeter]; 'PALESTINE / J. Palmoni' [leg glued to card]; 'TYPE' [black text on red card]; 'Pres by / Com Inst Ent / B M 1959–378'; '*Sturmiopsis* / Emdeni Mesn. / L. Mesnil det , 1950'. In poor condition; thorax extensively ruptured by pin dorsally and laterally; left legs largely detached and right fore leg missing.

Description:

Male:

Dimensions (mm): Body length 5.0; wing length 6.2.

Colour/pollinosity: Head mainly dark brown or black with silver pollinosity; pollinosity noticeably dense on parafrontal and to a lesser extent on parafacial. Ground colour of parafacial, facial ridge and lower extent of face yellow. Antenna with first and second segments yellow-brown and third segment dark brown to black. Gena dark yellow-brown to brown (somewhat paler than lower occiput), indistinctly silver or pale brown pollinose. Palp yellow-brown. Thorax almost entirely dark brown to black, but postalar callus and posterior two-thirds of scutellum yellow-brown; pollinosity almost entirely silver. Legs mostly dark brown to black. Wing completely hyaline, veins yellowish. Abdominal T1+2 and T3 mainly blackish, although yellow-brown laterally. T4 and T5 dark brown. Abdominal dorsum with silver pollinosity over much of T3, and on anterior two to three-fifths of T4 and T5; posterior sections of T4 and T5 golden pollinose.

Head: Outer and inner verticals detached, but outer verticals much weaker than inner verticals; 2 moderately developed reclinate orbital setae (both detached), probably similar in length to inner verticals, inserted just anterior to ocellar triangle. Parafrontal hairing relatively profuse and short, only reaching about one-fifth length of frontal setae. Parafacial hairing noticeably sparser than that on parafrontal and present on upper three to four-fifths of height, hairs absent from anterior and posterior margins. Second antennal segment short, just less than half length of A.s.3. Third aristal segment swollen in about basal one-quarter to half, maximum width usually obviously broader than that of basal aristomeres. Palp only slightly broader apically, apical extremity acutely pointed. Eye completely bare.

Wing (Fig. 1): Margin without subcostal spine. Basal node of R_{4+5} with 1–2 setulae. Cell r_5 narrowly open or almost closed at margin, distance along costa at most 0.4 X length of r-m. Bend of M sharply angled, with short appendix, bend positioned relatively distant to wing margin, distance about two-fifths distance from m-cu. Vein m-cu positioned two-thirds distance from r-m to bend of M.

Abdomen: T3 without median marginal setae. T4 with complete marginal setal row, this extended ventrally. T5 with irregular marginal row of setae.

Postabdomen (Fig. 6): *Cercus*: Modified, dorsally ridged medially, longer than surstylus in profile; hairing on lateral margins distributed on posterior two-fifths, longest hairs at posterior margin, these reaching about half to three-fifths length of entire cercus. *Surstylus*: Dorsal margin with convex flexure at basal two-fifths in profile; acutely rounded apically, extreme apex relatively sharply pointed. Hairs always present, although not on apical one-fifth, present on apical two to four-fifths; hairing restricted to ventral three-quarters, length of hairs short with longest and strongest hairs distributed along ventral margin, length of these reaching about half depth of surstylus in profile.

Discussion: According to Dr A. Freidberg (*pers. comm.*, 2004), Beth Gordon is a museum that was the former depository of the material examined (listed above), but could also be the locality where the material was collected. The holdings of the museum were all from the Sea of Galilee area. The male is the first known of this little-known species, and is consequently described above. I am convinced—based on venational and colour characters—that it is conspecific with the female holotype.

I can confirm that *S. emdeni* and *S. inferens* are distinct species, and they can in fact be relatively easily distinguished (see species key). Of note is the complete lack (even under high magnification) of eye hairing in both sexes of *S. emdeni*. At least some hairs are typically present in males of *S. inferens* and *S. parasitica* (e.g. Fig. 5). As only one male of *S. emdeni* is known, it is impossible to reliably separate it from the other two species using characters of the male postabdomen, given that it is likely to exhibit intraspecific variation in the form and shape of the cercus and surstylus.

Other material examined: ISRAEL: 1 ♀, 'Beth Gordon', 'A7068' (TAUI); 1 ♂, 'A7068' (TAUI).

Sturmiopsis inferens Townsend, 1916

Sturmiopsis inferens Townsend, 1916: 313; Mesnil 1952: 228; Crosskey 1976: 242, 1977: 682.
Winthemia semiberbis Bezzi, 1925: 115.

Type material examined: **Holotype** ♀ (USNM): INDONESIA: *Java:* 'Reared From / *Sesamia* / *inferens*'; 'Buitenzorg / IX.1913. / Java'; 'K. W. Dammer- /man.'; 'Type / No 20041 / U.S.N.M.' [black type on red card]; '*Sturmiopsis* / *inferens* / ♀ '. In fair condition; both wing tips and right fore and mid legs missing; setae on dorsal part of head abraded. **Paratype** ♂ (labelled allotype) (USNM): same label data.

Other material examined: 51 specimens (BMNH, TAUI, USNM) from Bhutan, India, Indonesia, Madagascar, Malaysia, Nepal and the Philippines were seen during this study (many with associated puparia). It is assumed that the Madagascan material was introduced from the Oriental Region.

Remarks: Material of this species was studied to confirm that it was distinct from *S. emdeni* and *S. parasitica*. Distinguishing character states are cited above in the key to species. Further study is required as marked intraspecific variation in the shape of the male cercus and surstylus was noted.

Of interest is the fact that the eyes vary from being almost bare to profusely haired with the hairs relatively elongate, although the eyes are nearly always haired in males.

Sturmiopsis parastica Curran, 1939

Figs 2–5, 7–12

Rhodesina parasitica Curran, 1939: 3.
Curranomyia parasitica: Townsend 1941: 115.
Sturmiopsis parasitica: Mesnil 1952: 228, 1959: 11; Crosskey 1980: 880, 1984: 286.
Sturmiopsis angustifrons Mesnil, 1959: 11; Crosskey 1980: 880, 1984: 290. **Syn. n.**

Type material examined: *Rhodesina parasitica*: **Holotype** ♂ (AMNH): ZIMBABWE: ‘*Rhodesina* / *parasitica* / Curran. ? / Holotype’ [rectangular red card]; ‘Salisbury / S. Rhodesia. / Dept. Agric. / DEC 1933’; ‘3587’. In fair condition; right fore and mid legs missing; fore tarsus detached; postabdomen dissected. An incomplete puparium is mounted with the adult. **Paratype** ♀ (labelled allotype) (AMNH): same locality data, numbered 1016. *Sturmiopsis angustifrons*: **Holotype** ♂ (SMNS): TANZANIA: ‘Kisangara / 31.xii–1.i.1952 / D.O. Afrika Exp.’ [black type on rectangular blue card]; ‘*Sturmiopsis* / *angustifrons* Mesn. / L. Mesnil det., 1958’; ‘TYPE’ [black type on rectangular red card]. In excellent condition; postabdomen dissected.

Redescription:

Male:

Dimensions (mm): Body length 3.6–5.1 (4.1); wing length 4.7–5.7 (5.2).

Colour/pollinosity: Head mainly dark brown or black with silver pollinosity. Parafrontal sometimes noticeably darker than mesofrons; both with silver or brown pollinosity. Parafacial yellow or brown pollinose; face indistinctly silver or yellow pollinose, ground colour sometimes yellow at lower extent. Antenna entirely dark brown to black, although sometimes irregularly paler; some specimens with A.s.1 and A.s.2 yellow and ventral

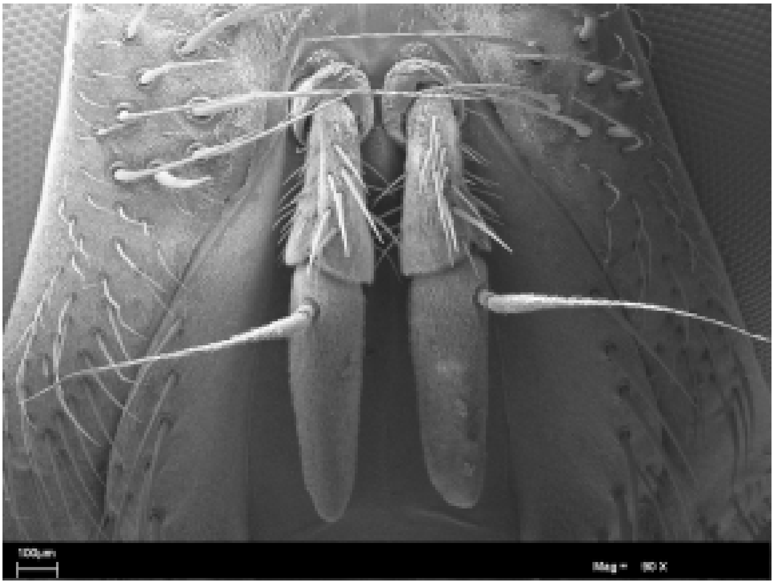


Fig. 4. *Sturmiopsis parasitica*; frontal view of antennae, showing relatively elongate second segment, and pubescent third aristal segment, which is swollen in about basal one-third. Note vestiture on adjacent parafacials and setae restricted to lower half of facial ridges. [SEM micrograph; scale as indicated].

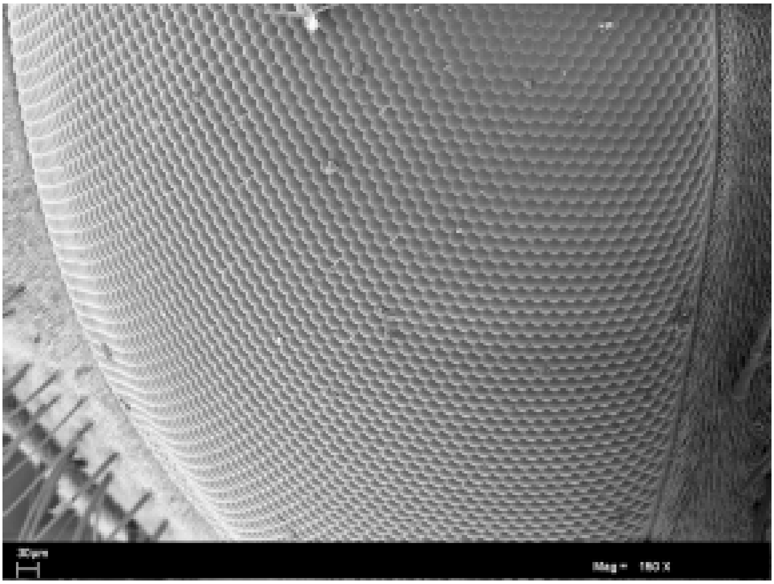


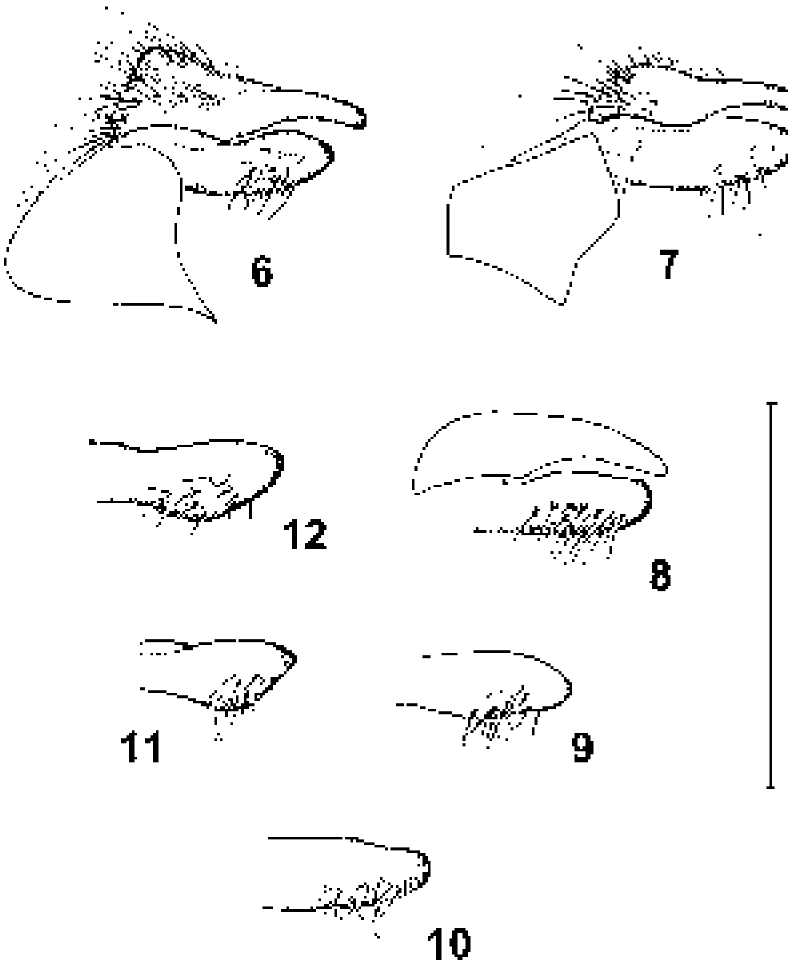
Fig. 5. *Sturmiopsis parasitica*; SEM micrograph showing part of male eye in lateral view, with reduced distribution of relatively widely separated, short hairs. [SEM micrograph; scale as indicated]

half to four-fifths of A.s.3 yellow or dark orange, although in other specimens these antennal sections only slightly or partly or irregularly paler. Gena dark yellow-brown to brown (usually somewhat paler than parafacial and lower occiput), indistinctly silver or pale brown pollinose. Palp yellow-brown to brown. Thorax almost entirely dark brown to black, but postalar callus and posterior margin of scutum sometimes indistinctly paler and lateral and posterior margins of scutellum (sometimes posterior tip ranging to apical two-thirds) yellow-brown; pollinosity almost entirely silver, but sometimes partly pale yellow on scutellum; pollinosity noticeably denser on mesonotum and scutellum. Legs almost entirely dark brown to black. Wing completely hyaline, veins yellowish. Abdominal T1+2 and T3 mainly blackish, although sometimes yellow-brown laterally (rarely markedly so). T4 dark yellow-brown to black, sometimes with indistinct blackish dorsomedial vitta, and rarely with yellow-brown lateral margins; T5 similar, but without dorsomedial vitta. Abdominal dorsum with silver pollinosity clearly evident on anterior quarter to three-fifths of T3–T5, darker sections of dorsum typically with brown pollinosity visible upon rotation.

Head (Figs 3–5): Outer verticals about two-fifths to half length of inner verticals; 2 (rarely 3) moderately developed reclinate orbital setae, both shorter than inner verticals, and inserted just anterior to ocellar triangle. Parafrontal hairing relatively profuse and short to moderately elongate, sometimes reaching about half length of frontal setae. Parafacial hairing sometimes slightly sparser than that on parafrontal; present on upper four-fifths to almost entire height. A.s.2 elongate, about two-thirds to three-quarters length of A.s.3. Third aristal segment swollen in about basal one-quarter to two-fifths, maximum width subequal to or noticeably broader than that of basal aristomeres. Palp broader apically, here reaching 1.5–2.5 X basal width; apical extremity acutely pointed. Eye with inconspicuous, short, sparse hairing (hairs often about 2–3 ommatidia apart), hairs sometimes restricted to posterior two-thirds of eye, or hairing completely absent.

Wing (Fig. 2): Margin with subcostal spine sometimes differentiated, albeit small. Basal node of R_{4+5} with 2–3 setulae. Cell r_5 narrowly open at margin, distance along costa 0.3–1.0 X length of r-m. Bend of M smoothly rounded (sometimes abruptly so), nearly always without short appendix, bend positioned close to wing margin, distance about one-fifth to one-third distance from m-cu. Vein m-cu positioned half to two-thirds distance from r-m to bend of M.

Abdomen: T3 with paired median marginal setae. T4 with complete marginal setal row, this extended ventrally. T5 with setae on posterior quarter to half, including discals.



Figs 6–12. Male terminalia in profile (vestiture usually shown on surstylus only) in specimens from selected localities. 6. *Sturmiopsis emdeni*. 7–12. *Sturmiopsis parasitica*. 7. Holotype of *S. parasitica* (Zimbabwe). 8. Cercus and surstylus, holotype of *S. angustifrons* (Tanzania). 9. Surstylus (Tanzania). 10. Surstylus (Kenya). 11. Surstylus (Nigeria). 12. Surstylus (Ghana). Scale = 1.0 mm.

Postabdomen (Figs 7–12): Cercus simple, not dorsally ridged medially, longer than surstylus in profile; hairing on lateral margins distributed on posterior one-fifth, longest hairs at posterior margin, these reaching about three-quarters length of entire cercus. *Surstylus* (Southern and East African population) (Figs 7–10): Flat along dorsal margin in profile, although sometimes slightly sinuous; acutely rounded (sharply to broadly) apically; somewhat broader basally or slightly broader at mid-length. Hairs always present, although not on apical one-fifth, usually present on apical two to four-fifths; hairing restricted to ventral half, length of hairs ranging from short to elongate with longest hairs distributed along ventral margin, length of these reaching depth of surstylus in profile. *Surstylus* (West African population) (Figs 11–12): Vestiture similar, albeit ventral hairs somewhat shorter; shape different, dorsal margin concavely curved at about basal one-third of length, ventral margin with moderate to marked convex flexure at about apical one-third.

Puparial spiracles: Small and flat, slightly raised above surface. Each spiracle comprising 2–3 clusters of serpentine ridges and with striking black perimeter. Spiracles closely approximated, sometimes virtually contiguous or separated by about one- to two-thirds width of each spiracle.

Female (differences from male):

Dimensions (mm): Body length 3.2–4.8; wing length 3.9–5.5.

Colour/Pollinosity: Head pollinosity completely silver, this usually strikingly dense on parafrontal and parafacial. Facial region and facial ridge sometimes largely yellow-brown.

Head: Parafrontal with 2 proclinate and 1 reclinate orbital setae, posterior proclinate orbital closer to insertion of reclinate orbital than that of anterior proclinate orbital; parafrontal hairs short, at most about one-fifth length of frontal setae. Parafacial hairing often sparse. Palp conspicuously swollen apically (club-shaped), apical extremity smoothly rounded, apical region at broadest extent slightly more than 3.5 X width of base, although sometimes noticeably narrower apically (width here reaching about 2.5 X that of base).

Remarks: According to Mesnil (1959), his new species *Sturmiopsis angustifrons* differed from *S. parasitica* by having a pair of strong median marginal setae on T3, the eyes almost bare, the occiput without black ‘microchetae’ on its upper part behind the postocular row, and the second antennal segment yellow. I have examined the holotypes of both *S. parasitica* and *S. angustifrons* and have concluded that the suite of character states of *S. angustifrons* fall within the variational range of a widened concept of *S. parasitica*, and that *S. angustifrons* is thus a junior synonym of *S. parasitica*. There is no significant difference in the development of the T3 median marginal setae as stated by Mesnil (1959: 11). Mesnil also insinuated that *S. parasitica* had eyes with significantly more hairing than *S. angustifrons*. This is incorrect; the holotype of *angustifrons* has discernible—albeit short—hairing on its posterior two-thirds (although hairs largely absent on its anterior third), while that of *parasitica* has comparable short hairing over much of its surface. In a wider concept of *S. parasitica* the eyes range from having irregularly scattered short hairing (hair length subequal to the width of two ommatidia, e.g. Fig. 5) over the entire surface of the eye, to being completely bare; this is quite unlike *S. inferens* where the eyes are nearly always obviously haired, with the length of the hairs often reaching the width of four to five ommatidia. Mesnil is correct in stating that the holotype of *angustifrons* differs in having black occipital setulae present behind the upper part of the postocular row (only pale hairing is evident in the holotype of *parasitica*). However this is of no taxonomic significance, as there are sometimes only one or two black occipital setulae present in some specimens. The holotype of *S. angustifrons* does have the antenna (especially the first two segments) extensively pale, unlike that of *S. parasitica* where the antenna is completely dark. There are, however, numerous intermediate colour forms, and a wider concept of *S. parasitica* thus has extensive intraspecific variation in antennal colour. In other respects the holotypes of *angustifrons* and *parasitica* differ in only a few minor colour characters.

I have identified two forms of surstylus shape (see description above), one from Southern and East Africa (specimens from Zimbabwe, Tanzania and Kenya dissected) and the other from West Africa (specimens from Nigeria, Ghana and Senegal dissected). There is a small possibility that these disjunct populations could represent distinct species, although additional material needs to be examined and ideally corroborating character states identified. I have dissected both the holotypes of *parasitica* (Fig. 7) and *angustifrons* (Fig. 8), collected in Southern and East Africa respectively, and both have a surstylus of similar shape in profile. I have not figured the distribution of *S. parasitica* as I have not made an exhaustive study of all available material, and in any event collected material was sourced almost entirely from specimens reared by economic entomologists, and not collected in the field. An extensive recent search of the Natal Museum's Diptera collection has not yielded any additional material, and I have not seen any field-collected material from South Africa, which is possibly outside the natural distribution of this species.

Other material examined: INDIA (introduced): 3♂2♀, Bangalore, 11.x.1974, C.I.B.C., *ex Chilo* sp. (AMNH). BENIN: 1♀, 'onne station?', 22.iv.1991, *ex Sesamia* on maize (BMNH). GHANA: 1♂ and associated puparium, N. Kawie, 29.xii.1969, I. K. Maafo, *ex Eldana saccharina* (AMNH); 1♀, Kpandu, Togoland, T. Volta, N. D. Jago, 28.xii.1959, to light (BMNH); 2♀, Kumasi, 1 with associated puparium, emerged 9.ii.1970, 25.ii.1970, I. K. Maafo, ex *Eldana sacharrina* (AMNH); 1♂ and associated puparium, same data except collected at Boni (AMNH); 1♂, Obuasi, 7.vi.1991, *ex Eldana saccharina* on maize (BMNH). KENYA: 1♂ and associated puparium, Kilifi, 'Kaloleni: *ex Chilo* sp.', C.I.B.C. (BMNH); 1♀, Kilindini, Mombasa Island, L. F. Brown, 19–23.viii.1955 (BMNH); 1♀ and associated puparium, reared at Washington D.C., emerged 16.x.1946, *ex* phalaenid larva in *Sorghum vulgare* (probably *Sesamia*) (AMNH). NIGERIA: 1♂ and associated puparium, Ibadan, 7.vi.1991, J. A. Ubeku, on maize, *ex Eldana saccharina*, pupa(ted) 13–14.vi.1991, em(erged) 25–27.vi.1991 (BMNH); 1♀ and associated puparium, Ibadan, 22.viii.1960, F. A. S., in gamba grass, *ex Coniesta* larva (BMNH); 1♂1♀, Samaru, Zaria, 25.ix.1959, *ex* pupa *Coniesta ignefusalis* (BMNH); 1♂, ix.1972, C.I.B.C., *ex Eldana saccharina* on sugarcane (AMNH). SENEGAL: 1♀, 15 mls N. Kaolack, 18.viii.1985, R. H. Markham, *ex Coniesta ignefusalis*, millet (AMNH); 1♂ and associated puparium, Nioro-du-Rip, x.1982, recovered from larvae of *Acigona ignefusalis* on pearl millet (BMNH). TANZANIA: 1♂1♀ (same mounting), 2 associated puparia, Mbeya, 14.v.1957, I.W.B. Nye, reared *ex Busseola fusca* (BMNH); 1♀, Songea, iii.1966, J. E. D. Milner, *ex B. fusca* (BMNH).

ZIMBABWE: 1♂, Salisbury, ix.1956, C. N. Smithers, *ex* larva of *Busseola fusca* (BMNH); 1♀ , Salisbury Dist., 24.ii.1954, Dept. Agric., par. stalk borer (BMNH); 1♀ , Sby. Expt. Stn., ix.1968, R. P. Mparutsa, parasite of *Busseola fusca* (NMSA); 2♂, 1 with associated puparium, Dept. Agric., 2.xii. & 25–27.xii.1953, parasite of stalk borer, (*ex*) *Busseola fusca* (BMNH, NMSA).

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REFERENCES

Barraclough, D. A. 1991. A new species of Tachinidae (Diptera) parasitic on the sugarcane borer *Eldana saccharina* (Lepidoptera: Pyralidae), in Natal, South Africa. *Bulletin of Entomological Research* **81** (1): 133–136.

——— 1992. The systematics of the Australasian Dexiini (Diptera: Tachinidae: Dexiinae) with revisions of endemic genera. *Invertebrate Taxonomy* **6**: 1127–1371.

Bezzi, M. 1925. Some Tachinidae (Dipt.) of economic importance from the Federated Malay States. *Bulletin of Entomological Research* **16**: 113–123.

Carnegie, A. J. M. 1991. Cane borers in Africa and recent work on *Eldana saccharina*. Discussion document, International Society of Sugarcane Technologists' workshop, West Palm Beach, Florida, 11–15 March, 11 pp.

Chinwada, P, Overholt, W. A., Omwega, C. O. & Mueke, J. M. 2004. Biology of *Sturmiopsis parasitica* (Diptera: Tachinidae) and suitability of three cereal stem borers (Lepidoptera: Crambidae, Noctuidae) for its development. *Annals of the Entomological Society of America* **97** (1): 153–160.

Conlong, D. E. 1994. A review and perspectives for the biological control of the African sugarcane stalkborer *Eldana saccharina* Walker (Lepidoptera: Pyralidae). *Agriculture, Ecosystems and Environment* **48**: 9–17.

——— 2000. Indigenous African parasitoids of *Eldana saccharina* (Lepidoptera: Pyralidae). *Proceedings of the South African Sugar Technologists' Association* **74**: 201–211.

Crosskey, R. W. 1976. A taxonomic conspectus of the Tachinidae (Diptera) of the Oriental Region. *Bulletin of the British Museum (Natural History) Entomology*, Supplement **26**: 1–357.

——— 1977. Family Tachinidae. *In*: Delfinado, M. D. & Hardy, D. E., eds, *A catalog of the Diptera of the Oriental Region*. Volume III. Suborder Cyclorrhapha (excluding Division Aschiza). Honolulu: The University Press of Hawaii, pp. 586–697.

——— 1980. Family Tachinidae. *In*: Crosskey, R. W., ed., *Catalogue of the Diptera of the Afrotropical Region*. London: British Museum (Natural History), pp. 822–882.

——— 1984. Annotated keys to the genera of Tachinidae (Diptera) found in tropical and southern Africa. *Annals of the Natal Museum* **26** (1): 189–337.

Curran, C. H. 1939. African Tachinidae – II. *American Museum Novitates* **1022**: 1–5.

Greathead, D. J. 1971. A review of biological control in the Ethiopian region. Commonwealth Institute of Biological Control, Technical Communication No. **5**: 1–162.

Harris, K. M. 1998. Diptera. *In*: Polaszek, A., ed., *African cereal stem borers: economic importance, taxonomy, natural enemies and control*. Oxon & New York: CAB International, pp. 265–281, 500–514.

Herting, B. 1984. Catalogue of Palearctic Tachinidae (Diptera). *Stuttgarter Beiträge zur Naturkunde* A **369**: 1–228.

INGRAM, W. R. 1983. Biological control of graminaceous stem-borers and legume pod borers. *Insect Science and its Application* **4**: 205–209.

KFIR, R. 2001. Prospects for biological control of *Chilo partellus* in grain crops in South Africa. *Insect Science and its Application* **21** (4): 275–280.

MARTIN, A. J., CONLONG, D. E. & SLOTOW, R. 2001. Temperature tolerances of *Sturmiopsis parasitica* (Diptera: Tachinidae). *Proceedings of the South African Sugar Technologists' Association* **75**: 186.

MESNIL, L. P. 1952. 64g. Larvaevorinae (Tachininae). *In*: Lindner, E., ed., *Die Fliegen der Palaearktischen Region*. Stuttgart: Schweizerbart'sche Verlagsbuchhandlung, pp. 209–256.

——— 1959. Tachinidae d'Afrique orientale (Dipt.) (Récoltés par l'expédition zoologique allemande en Afrique orientale de 1951/52. Groupe Lindner – Stuttgart, Nr. 33). *Stuttgarter Beiträge zur Naturkunde* **23**: 1–31.

SCHEIBELREITER, G. K. 1980. Sugarcane stem borers (Lep.: Noctuidae and Pyralidae) in Ghana. *Zeitschrift für angewandte Entomologie* **89**: 87–99.

TOWNSEND, C. H. T. 1916. New genera and species of muscoid flies. *Proceedings of the United States National Museum* **51**: 299–323.

——— 1941. *Curranomyia* nom. nov. for *Rhodesina* Curr., (preocc.). *Transactions of the Rhodesian Scientific Association* **38**: 115–116.